serves, that luxuriant shoots, which abound in sap, constantly turn upwards, and endeavour to acquire a perpendicular direction; but that the feeble and more slender shoots grow in almost every direction, probably from their fibres being more dry, and their vessels less amply supplied with sap, so that they are less affected by gravitation. To the second objection, Mr. Knight answers, that the compression of the radicle, as it penetrates the soil, obstructs the motion of the sap, and occasions the generation of numerous lateral roots; and as their substance is less succulent than that of the radicle first emitted, they are less obedient to gravitation, and consequently extend horizontally in every direction. Respecting the tap-root of the oak, the author says he has examined at least 20,000 trees of that species, and never found one tree that possessed a tap-root; he therefore thinks he may be allowed to doubt the existence of such a root.

A third Series of Experiments on an artificial Substance, which possesses the principal characteristic Properties of Tannin; with some Remarks on Coal. *By* Charles Hatchett, *Esq. F.R.S.* Read January 16, 1806. [*Phil. Trans.* 1806, *p.* 109.]

Mr. Hatchett, in his former communications on this subject, gave some account of the effects produced by sulphuric acid upon turpentine, resin, and camphor. He now states the results of a variety of experiments made with that acid upon a great number of resins, balsams, gum-resins, and gums; from which it appears, that sulphuric acid almost immediately dissolved the resins, forming transparent brown solutions, which gradually became black; that the solutions of the balsams and of guaiacum were at first of a deep crimson colour, slightly inclining to brown; and that caoutchouc and elastic bitumen were not dissolved, but, after a long digestion, were only superficially carbonized.

Turpentine, common resin, elemi, tucamahaca, mastic, copaiba, copal, camphor, benzoin, the balsams of Tolu and of Peru, assafœtida, and amber, yielded a large proportion of the tanning substance; so also did oil of turpentine.

Asphaltum yielded only a small portion of that substance; and some slight traces of it were obtained from gum arabic and from gum tragacanth; but none was produced from guaiacum, dragon's blood, myrrh, gum ammoniac, olibanum, gamboge, caoutchouc, elastic bitumen, liquorice, and manna. Mr. Hatchett thinks, however, that some of these would have yielded it, had not the digestion with nitric acid been too long continued.

Olive oil was partly converted into the tanning substance; so also were linseed oil, wax, and animal fat. In the experiment with linseed oil, a portion was left undissolved: this portion appeared to retain many of the properties of an inspissated fat oil. In the experiment made with wax, a white substance was obtained, which was found to possess the properties of spermaceti. In that with animal fat (in which the kidney-fat of veal was employed), a great

portion of a grayish-black substance was produced, which was highly inflammable, was easily melted, and was readily dissolved in cold alcohol; from which, like the resins, it might be precipitated by water.

From coagulated albumen, and from prepared muscular fibre, nothing but coal could be obtained.

In the above experiments there appeared to be a certain period of the process when the production of the tanning substance arrived at its maximum; after which a gradual diminution, and at length a total destruction of it, took place, and it became mere coal.

Some experiments are now related, made with nitric acid, on the elastic bitumen, and on several kinds of coal. The result was, that from elastic bitumen, common pit-coal, Cannel-coal, and asphaltum, there was obtained, not only the tanning substance, but also another substance, which possessed properties intermediate between those of resin and those of vegetable extractive matter; but this substance might, by digestion in nitric acid, be converted into the tanning substance. From Kilkenny-coal, and from two other kinds of coal, one from Wales, the other from North America, none of the above-mentioned resinous substances were obtained.

Mr. Hatchett now proceeds to mention a variety of experiments made on horse-chestnuts, and on their peels. From these it appeared, that the small portion of tannin originally contained in horse-chestnut peels is destroyed by the process of roasting; but that the brown decoctions of the roasted horse-chestnuts, and of their peels, might be made to afford the tannin matter, by the addition of nitric acid. The above brown decoctions appeared to contain carbon, combined with oxygen, sufficient to give it many of the properties of coal; but the compound is nevertheless capable of being dissolved by water with great facility.

Solutions similar to the above may, our author thinks, be obtained whenever vegetable matter undergoes the putrefactive process, as in dunghills, &c. He examined the brown liquor that runs from walnut-peels when kept in a heap for a certain time, and found that, like the decoctions above mentioned, it contained carbon in a state approaching to coal, and that, by the addition of nitric acid, a small portion of the tanning substance might be procured from it.

Some experiments were likewise made upon galls; the results of which showed, that the natural tannin contained in them is destroyed by nitric acid; that it is also diminished, and ultimately destroyed, by roasting; but when the galls have not been so much roasted as to destroy the whole of the tannin, the remainder of that substance is destroyed by the addition of nitric acid, whilst, at the same time, a small portion of the artificial tannin is produced.

Results nearly similar were obtained from experiments upon oak-bark; and it also appeared, that when that bark was exhausted of its natural tannin, it might, by roasting and being treated with nitric acid, be made to yield the artificial tanning substance. This process was several times repeated upon the same portion of bark; and as it

still continued to yield the tanning substance, our author thinks it probable the process might be repeated until the whole of the bark became converted into the above substance.

From the foregoing experiments, and many others made by him, Mr. Hatchett thinks that the method of treating roasted vegetable substances here described is the most speedy and economical for obtaining the artificial tanning matter; and, as all refuse vegetables may be thus converted into that matter by simple and unexpensive means, he hopes the discovery may eventually be productive of some real public advantage.

In a former paper Mr. Hatchett observed, that he suspected the tannin found in some peat-moors was produced during the imperfect carbonization of the original vegetable substances: whether that is really the case, or whether it has been afforded by heath or other vegetables growing upon and near the peat, is, he says, still uncertain, as he has never been able to detect any tanning substance in peat, although he has examined a considerable number of varieties of it. The great facility with which tannin is dissolved by water causes it to be speedily extracted and drained from the substances which at first contained it: and that this facility of extraction extends to the most solid vegetable bodies, is shown by an experiment made by our author on a piece of oak from the submerged forest at Sutton, on the coast of Lincolnshire, described in the Phil. Trans. for the year 1799. This oak, by decoction, afforded extractive matter, but no traces of tannin could be perceived; yet, by incineration, it even afforded potash.

Peat, however, although it does not contain tannin, is, by the imperfect carbonization it has undergone, rendered capable of being converted, by treatment with nitric acid, into the artificial tanning substance, in the manner already mentioned with respect to roasted ligneous bodies.

In the following section of his paper, Mr. Hatchett compares the effect of the acetic, sulphuric, and nitric acids, upon resinous substances. The first of these he considers as the solvent of such substances, as it dissolves them speedily, without producing any apparent subsequent change in their natural properties; so that, by proper precipitants, they may be separated from that acid in an unaltered state. Sulphuric acid immediately dissolves resinous substances; but the moment the solution is complete, progressive alterations appear to take place in the dissolved substance, coal being the ultimate product.

The effects of nitric acid seem to be the reverse of those of the sulphuric; for by nitric acid the resins are converted into a brittle porous substance, then into a soluble product intermediate between extractive matter and resin, which product is converted into the first variety of the tanning substance; beyond which our author has not been able to effect any change. A table of the quantity of coal remaining after the treatment of various resinous substances with sulphuric acid is now given; respecting which we shall

only remark, that a much greater proportion of coal is obtained from those substances by means of the above acid than can be obtained by distillation.

Two experiments on the humid formation of coal are also described: from one of these it appears that oak-wood may, by sulphuric acid, be converted into a coal which is very different from charcoal, and which, by its mode of burning, and by its not affording any alkali, resembles those mineral coals that do not contain bitumen.

The other experiment shows that oak-wood may also be converted into a sort of coal by muriatic acid; but this coal retains some vegetable characters, although no alkali can be obtained from its ashes.

Mr. Hatchett now proceeds to make some remarks on the natural formation of coal. After stating the various theories that have been formed on that subject, he considers as the most probable the theory which ascribes the principal origin of coal to vegetable substances; that idea of its origin being, he says, corroborated by the greater number of geological facts. The observations, however, that have been made upon the submerged wood found at Sutton and other places, show, our author thinks, that vegetable substances, buried under the sea or under the earth, are not, merely by such means, converted even into the most imperfect sort of coal; some other process being evidently necessary to produce this change, which in a former paper he endeavoured to demonstrate to be progressive.

That some sorts of coal are of vegetable origin, there cannot, Mr. Hatchett says, be any doubt: several of them, as the Bovey coal, the Sussex coal, the surturbrand, &c. not only still retain some of their external vegetable characters, but also yield resin,—a substance allowed to belong exclusively to organized natural bodies. Some mineralogists, however, have attempted to distinguish the above-mentioned coals from others, which they denominate True Mineral Coals: but it has in the former part of this paper been shown, that when pit-coal, Cannel-coal, and asphaltum, (which are considered as of mineral origin,) are subjected to the action of nitric acid, and the process is stopped at a proper period, there remains a substance which is intermediate between resin and vegetable extractive matter. It has also been stated, that, by similar means, a substance possessing nearly the same properties may be obtained from the known vegetable resins.

Our author indeed admits that bitumen has never been formed by any artificial process, and that he has himself attempted it, in various ways, without success: yet we may conclude, from what has been already said, that bitumen is a modification of the resinous and oily parts of vegetables, produced by some process of nature, operated by gradual means on immense masses; and we have, he thinks, great reason to conclude that the agent employed by nature in the formation of coal and bitumen is either the muriatic or the sulphuric acid. Common salt, however, is never found in coal-mines, except when they are in the vicinity of salt-springs; whilst, on the contrary, py-

rites, sulphate of iron, and alum, are commonly found in such mines; from which circumstances, together with the sulphureous odour emitted by most of the mineral coals when burned, the agency of sulphuric acid is strongly evinced; and, as we have already observed, the coals formed artificially from vegetable substances, by means of sulphuric acid, bear a strong resemblance to the mineral coals, not only in their external characters, but also in their other properties.

Mr. Hatchett intends, he says, to relinquish any further prosecution of this subject for the present; but he entertains such sanguine expectations of its proving economically useful, that he strongly recommends the prosecution of the inquiry, particularly of that part which relates to roasted vegetable substances and to peat.

The Application of a Method of Differences to the Species of Series whose Sums are obtained by Mr. Landen, *by the Help of impossible Quantities. By Mr.* Benjamin Gompertz. *Communicated by the Rev.* Nevil Maskelyne, *D.D. Astronomer Royal, F.R.S.* Read February 13, 1806. [*Phil. Trans.* 1806, *p.* 147.]

The nature of this paper is such, as renders it absolutely incapable of abridgement. By way of introduction to it the author observes, that having some years back, when reading the learned Mr. Landen's fifth memoir, discovered the manner of applying a method of differences to the species of series whose sums are there obtained by the help of impossible quantities, and having since extended that application, he now ventures to offer it to the consideration of others.

The practice of this method, in most cases, appears, he says, extremely simple, and on that account he is almost induced to imagine that it has already been considered by mathematicians. And he acknowledges that, since the greatest part of the paper was written, he has, in Euler's Institutiones Calculi Integralis, met with two simple series, which are in that work summed by multiplications similar to those employed in the investigation of the principal theorems contained in this paper. But whether that learned mathematician has pursued the method any further, he has not been able to ascertain.

Mr. Gompertz has purposely considered some of the series summed by Mr. Landen, in order to procure an opportunity of comparing both the results and methods; and as the series may have particular cases, in which both Mr. Landen's means and those of our author fail, he has added, towards the end, a general Scholium concerning the causes, circumstances, and consequences of such failure.

An Account of a small Lobe of the human prostate Gland, which has not before been taken notice of by Anatomists. By Everard Home, *Esq. F.R.S.* Read February 20, 1806. [*Phil. Trans.* 1806, *p.* 195.]

The subject of this paper is a portion of a gland which, from the smallness of its size, and the obscurity of its situation, has hitherto